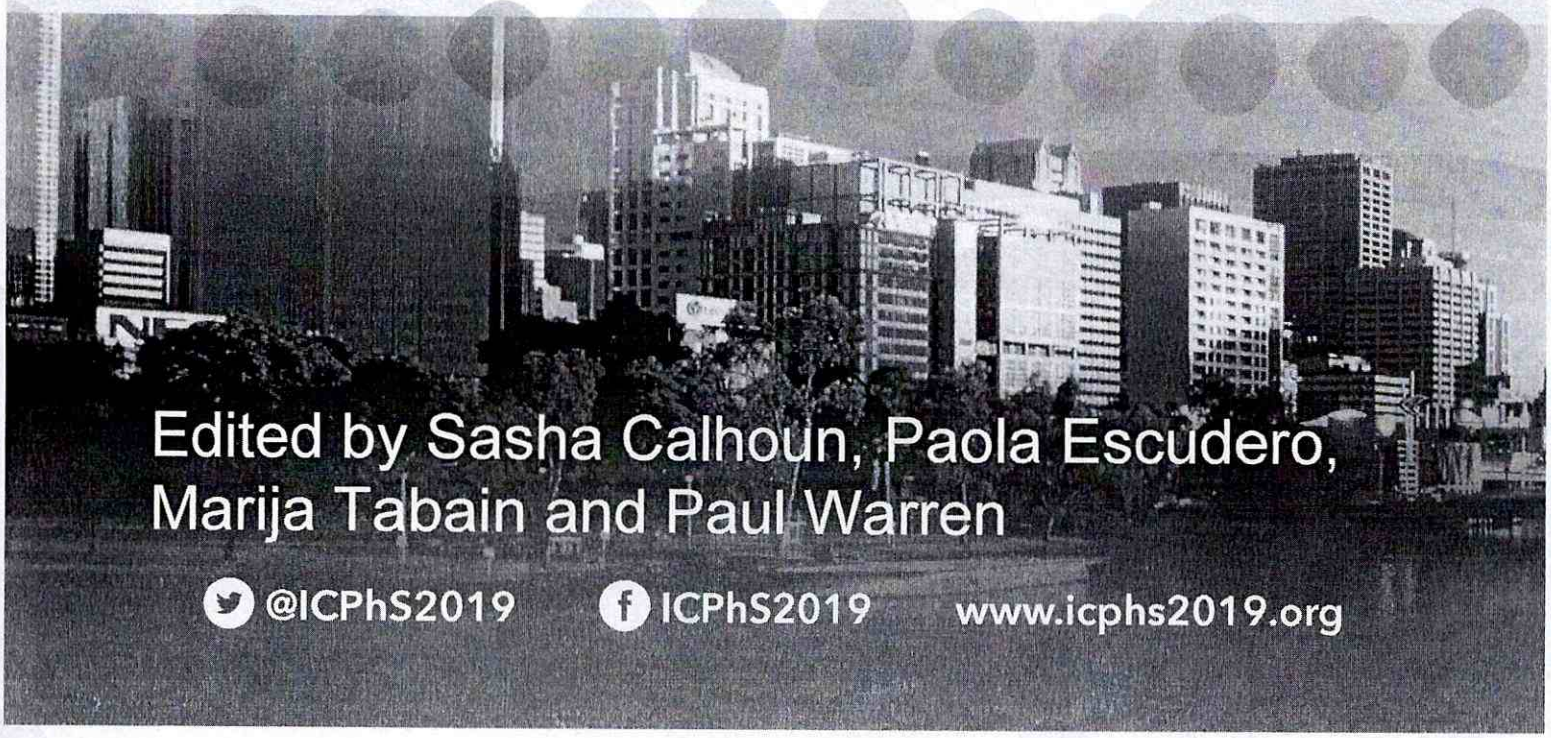
Proceedings of the 19th International Congress of Phonetic Sciences, Melbourne, Australia 2019

# ICPhS2019

5-9 August 2019 | Melbourne Australia



# 19TH INTERNATIONAL CONGRESS OF PHONETIC SCIENCES 2019

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## Acknowledgement of Country

**Womindjeka / Wominjeka! Welcome to Melbourne.**

ICPhS 2019 respectfully acknowledges the Traditional Custodians of the land, the Boon Wurrung and Wurundjeri peoples of the Kulin Nation and pays respect to their Elders, past and present.

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# WELCOME TO ICPhS 2019

## Welcome from the Chair of the Organising Committee for ICPhS 2019

On behalf of the Organising Committee, I am very excited to welcome you to Melbourne and to Australia for the 19th International Congress of Phonetic Sciences! Melbourne is my beloved home town, and in the words of our national anthem, "For those who've come across the seas, we've boundless plains to share". We're very grateful to those of you who've made the long journey to be with us here today and I hope you'll take a little bit of time to explore this beautiful and big country of ours. Whilst the weather in Melbourne is not very inviting in August, it is much better if you are able to travel "up North". Nonetheless, for those of you who appreciate the cooler climes, Melbourne is wonderful in winter too, with lots of cosy cafes and restaurants, as well as arts and cultural venues and various sporting activities (including our local Australian football). I also hope that most of you will make time to go to the beach – it is only a short tram ride from the congress venue and a lovely chance to be with nature in an otherwise very busy city.

Our congress themes for ICPhS 2019 are **"Endangered Languages" and "Major Language Varieties"**. Melbourne is the fastest growing city in Australia, with migrants from all over the world; and although English is the most widely-spoken language, there is a very large variety of community languages spoken here as well. We are also very proud in Australia of our Aboriginal heritage; and although indigenous communities in Australia suffered greatly as a result of British settlement – leading to tremendous language loss in certain regions – some strong language communities and cultures remain despite invasion. I am also pleased to note that ICPhS 2019 is being supported by our "Kiwi cousins" in New Zealand, who like us speak a "New World" variety of the English language brought to us by the British settlers, as well as te reo Māori, the indigenous language of New Zealand.

I would like to express my gratitude to several organisations which have been instrumental in bringing ICPhS to Melbourne in 2019. I would first of all like to thank the Australasian Speech Science and Technology Association, which celebrated its 30th anniversary in 2018, as well as the International Phonetic Association; the two host organisations for this flagship congress of the IPA. I would also like to thank the various university sponsors – La Trobe University, Macquarie University, Victoria University of Wellington, Western Sydney University, and the Australian Research Council Centre of Excellence for the Dynamics of Language – for providing generous funding from the outset. Their support gave us the confidence to bring this event to you today. It is the first time ICPhS is being held in the Southern Hemisphere, and we hope that you will find it a most memorable experience.

**Marija Tabain**
*Chair – 19th ICPhS*

# Welcome from the President of the Permanent Council of the ICPhS

Dear colleagues,

On behalf of the Permanent Council for the Organisation of the International Congress of Phonetic Sciences, it is a great honour to welcome you to the 19th International Congress of Phonetic Sciences in Melbourne. It is the first time that the Congress is being held in Australasia; indeed the first, but hopefully not the last, time that the Congress is taking place in the southern hemisphere. And about time, too! Australian and New Zealand phonetics have a long and rich tradition and work at a number of different locations has built up a formidable reputation of excellent phonetic research, not least for the careful and comprehensive analysis of many of the severely endangered indigenous languages, ranging from traditional phonetic description to detailed instrumental analysis. It is also very fitting therefore that, for the first time, this Congress has an explicit theme highlighting the importance, but also the problems, of analysing and documenting endangered languages both here and around the world.

Quantitatively, despite its name, the ICPhS has been a European congress. With Montreal in 1971 and San Francisco in 1999, the ICPhS only just managed 2 out of 14 non-European venues in the 20th century. But we are fast becoming statistically better. Including San Francisco again, if I may, the last twenty years have seen 50% of the ICPhS meetings being hosted at non-European venues. It would be a good figure to maintain. Regardless of location, though, the ICPhS has always been an inclusive and, from its outset, a strongly interdisciplinary congress, embracing not only a large number of different colleagues from around the world but, more importantly, bringing together different disciplines and methodologies to examine the production, transmission and perception of speech. So, the words of Wilhelm Horn in his opening address to the second ICPhS in 1935 are as relevant today as they have ever been: "Vertreter der Naturwissenschaften und Vertreter der Geisteswissenschaften reichen sich die Hand. Sie haben verschiedene Ausgangspunkte, verschiedene Ziele, verschiedene Methoden. Es ist für jeden einzelnen wertvoll und reizvoll, die Fragestellung und die Arbeitsweise der anderen kennen zu lernen.[1]" At the same time, I hope that nowadays we analyse our data and interpret our results a little more soberly than some of our colleagues used to. In her analysis of palate shape at the same congress, Kaiser makes the somewhat sweeping remark, "[a]s a contribution to the knowledge of the relation between speech and personality I might say that about the speakers with low palates there was, to me at least, something simple and honest, whereas the other speakers gave me the impression of being more complicated. This would agree well with the statements that the high palate is a mark of civilization and of neurosis."

I would like to finish by expressing our heartfelt thanks to the local organising committee, both on behalf of the Permanent Council and, also on behalf of all of those attending, for all the hard work that you have put into preparing the Congress, work that started well before the last meeting in Glasgow when the initial bid to host the Congress was submitted. On top of the administrative stamina needed to organise this Congress, you have put together an exciting scientific programme with almost 800 contributions from over 1,400 authors. I hope that you, and I am sure that the rest of us, will profit from the fruits of your hard work.

**Adrian P. Simpson**
*President of the Permanent Council for the Organisation of the ICPhS*

[1]Representatives of the natural sciences and representatives of the humanities shake hands. They have different starting points, different goals, different methods. It is valuable and attractive for each individual to get to know the questions and working methods of the others.

# Welcome from the President of the Australasian Speech Science and Technology Association (ASSTA)

On behalf of the Australasian Speech Science and Technology Association (ASSTA) I would like say g'day and to extend a very warm welcome to all delegates, invited guests and friends attending the 19th ICPhS in Melbourne 2019. A consortium of phoneticians from eight universities across Australia and New Zealand has been instrumental in bringing the congress together. This dedicated band has worked tirelessly over the past four years to create an event that we believe will excite, engage and enlighten in both expected and unexpected ways.

We have a very long tradition of excellence in phonetic research in Australia and New Zealand. Our professional body ASSTA was formed in 1988 with the aim of advancing the understanding of speech science and fostering interdisciplinary speech research. A major focus of ASSTA is to bring together researchers with a shared passion for phonetics. It is therefore a great privilege to host the flagship congress of the IPA and to invite researchers from across the globe to attend the first ICPhS to be held in the Southern Hemisphere.

ASSTA is committed to supporting not only established researchers but to nurturing emerging generations of speech scientists. ICPhS 2019 gives students and early career researchers the opportunity to engage with luminaries in the field, to experience first-hand the exhilaration of lively discussion and the exchange of cutting-edge ideas. We hope it also engenders a sense of belonging to a community of scholars and inspires future careers.

The United Nations General Assembly has declared 2019 the International year of Indigenous Languages so it is fitting that 'Endangered Languages' is one of the major themes of this congress. Tragically, an estimated 90 per cent of Aboriginal and Torres Strait Islander languages are endangered. Phoneticians are making a positive contribution to endangered languages in Australia and around the world through careful phonetic documentation and analysis, and engagement with communities in an effort to help raise awareness of indigenous languages and improve language preservation, promotion and revitalisation.

The second congress theme 'Major Language Varieties' is also of importance in this part of the world. Australia is a highly multicultural society and home to a wide variety of migrant languages from Europe, Asia, Africa and the Middle East. Of course, Australian and New Zealand English are two 'New World' Englishes, and te reo Māori, a language that is being actively recovered and protected, is an official language of New Zealand. We have a rich history of phonetic research involving these interesting varieties.

Those of you who have attended our biennial ASSTA conference in the past - the Australasian International Conference on Speech Science and Technology (SST) - will know that a highlight of that event is the 'Spectrogram Reading Competition' which has been a regular feature of the conference dinners for over 30 years. We are delighted to bring the 'Spectrogram Reading Competition' to the 2019 ICPhS congress dinner. The competition is fiercely fun and I know you will get a kick out of the competitive spirit it unleashes in even the mildest of phoneticians.

Conferences such as this would not be possible without the generosity of many individuals and organisations. We would like to thank our inspiring keynote speakers, the scientific committee and reviewers, institutional and corporate sponsors, the organising committee, student helpers, our professional conference organiser Arinex, and you, our delegates, for supporting ICPhS in 2019.

We welcome you to Melbourne and hope that you can explore parts of Australia (and hopefully make the trip 'across the ditch' to New Zealand), to engage with the locals and relax in this beautiful part of the world. We trust that ICPhS will be remembered for ideas exchanged, collaborations forged, exciting insights and inspiration gained, but most importantly for old friends reunited and new friendships made.

**Felicity Cox**
*President of ASSTA*

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# Contents

## Tue 6th Aug; Speech corpora and big data



## Tue 6th Aug; Speech perception



## Tue 6th Aug; Speech production and articulatory phonetics

# THE SECONDARY ROLES OF AMPLITUDE AND F0 IN THE PERCEPTION OF WORD-INITIAL GEMINATES IN KELANTAN MALAY

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## ABSTRACT

This study examines the extent to which amplitude and F0 play secondary roles in perceptually cueing the word-initial singleton/geminate consonant contrast in Kelantan Malay (KM). Three voiceless stop word-pairs produced in isolation, i.e. utterance-initial position, were chosen for manipulation in three perception experiments involving KM native listeners. Results show that amplitude and F0 have limited perceptual functions on their own, although the combined values of the two parameters do have some effect on the perception of the consonant contrast. These results are expected for the utterance-initial voiceless stop pairs given the absence of closure duration information as a perceptual cue in this context. The findings support the view that the consonant length distinction in word-initial position, particularly for voiceless stops, can be potentially cued by a set of secondary parameters, e.g. amplitude and F0, alongside the primary acoustic parameter of closure duration.

**Keywords**: amplitude, F0, word-initial consonant contrast, geminate perception, Kelantan Malay

## 1. INTRODUCTION

Closure duration has been established as a powerful cue to consonant gemination across languages, e.g. [11, 12]. However, many studies suggest that there may be additional acoustic cues that influence the perception of word-initial geminates, particularly in the case of voiceless stop geminates produced in utterance-initial position in which closure duration is acoustically unavailable and, therefore, potentially perceptually indiscernible. In this context, amplitude and F0 have been shown to be potential perceptual cues to the word-initial consonant contrast, such as in Pattani Malay (henceforth PM), which is closely related to KM (see also [9, 10]).

In a perception experiment in PM [2], amplitude was manipulated involving a voiceless stop word-pair produced in isolation. The results show that the amplitude modification of the first syllable of a word beginning with a singleton or a geminate, respectively, brings about different responses. Nevertheless, the response curves never cross the perceptual boundaries at 50%, suggesting that, in PM, amplitude variation alone is a weak cue to consonant gemination. In a subsequent experiment in PM [3], F0 values were modified in the first syllable of a voiceless stop word-pair produced in isolation. The results indicate that F0 shifts have some perceptual effect on PM listeners. However, like the previous experiment, the curves do not cross over the 50% perceptual boundaries. In the final perception experiment in PM [4], both amplitude and F0 values were co-varied in the first and second syllables of isolated tokens. The results reveal that the amplitude/F0 variation is sufficient to cause perceptual crossovers to the opposite categories.

In KM, the primary role of closure duration in the production and perception of the word-initial singleton/geminate contrast has been demonstrated in earlier acoustic studies, e.g. [6, 7]. With regard to amplitude and F0, their potential secondary functions in characterising such a contrast have been shown to be reliable in KM, as reported in [8]. The current study aims to examine whether and how controlled changes in amplitude and F0, both on their own and in combination, may also serve as perceptual cues to word-initial geminates among KM native listeners, especially in utterance-initial voiceless stops in which closure duration information is not present. Findings will confirm the relative saliency or otherwise of these non-durational acoustic cues that have also been observed in PM.

## 2. METHOD

### 2.1. Materials

The voiceless stop word-pairs chosen for manipulation in three perception experiments in this study are displayed in Table 1. The word-pairs in all experiments were produced in isolation, i.e. utterance-initial position. Although different minimal pairs were used for different experiments, the acoustic findings reported in [8] confirm the general patterns of potential acoustic properties of consonant gemination associated with utterance-initial voiceless stops.

**Table 1**: Sources of stimuli.

| Experiment | Singleton | | Geminate | |
|---|---|---|---|---|
| | Word | Gloss | Word | Gloss |
| 1 (amplitude) | /pagɪ/ | morning | /ppagɪ/ | early morning |
| 2 (F0) | /pɪtʊ/ | door | /ppɪtʊ/ | at the door |
| 3 (amplitude & F0) | /tɪdo/ | sleep | /ttɪdo/ | sleep by chance |

The procedures for manipulation were achieved by using the manipulation editor in Praat version 6.0.43 [5]. In Experiment 1, following the previous work on PM [2], the amplitude at vowel onset was either increased (after singletons) or decreased (after geminates) in five 2-dB steps. In Experiment 2, motivated by [3], the F0 at vowel onset was either increased (after singletons) or decreased (after geminates) in five half-semitone steps. In Experiment 3, following [4], both amplitude and F0 values at vowel onset were either incremented (after singletons) or decremented (after geminates) in three 2-dB steps and three half-semitone steps (see Table 4 in Section 3.3 for details). Twelve stimuli including their original words were each created for the word-pairs in Experiments 1 and 2, while 32 stimuli were created for the word-pair in Experiment 3. All stimuli were presented three times to the listeners, creating a total of 168 manipulated trials for all three experiments.

### 2.2. Listeners and data collection

The participants for all experiments were 30 undergraduate students (15 males, 15 females), all native speakers of KM, at the Universiti Malaysia Kelantan. Their ages ranged between 20 to 25 years (mean age: 21.2). All of the listeners were born and raised in Kelantan, Malaysia. The perception experiments began with Experiment 1, followed by Experiment 2 and then Experiment 3. The listeners participated individually in each experiment in a quiet room at the Universiti Malaysia Kelantan. They were seated at a desk and were fitted with a stereo headphone. All the stimuli were presented through a computer using Praat's Experiment Multiple Forced Choice listening experiment (version 6.0.43). The participants listened to a sound and chose the word that most closely resembled to what they listened. Since there is no written counterpart of KM, all words were written in Standard Malay. In each experiment, only one word-pair was tested at a time. All experiments lasted for approximately 30 minutes for each participant. All listeners were financially compensated for their participation.

### 2.3. Data analysis

The responses for each listener and each stimulus were processed using Microsoft Excel (Office 365). Since the stimuli were presented three times in each experiment, the scores for the correct responses ranged from 0 to 3. These scores represented the correct responses for geminates. The total scores for each stimulus were then converted into percentages and plotted into response curves. Geminate responses to each series of stimuli made from original singletons or geminates were submitted to one-way ANOVA tests using SPSS (version 25.0.0.0) to determine their significance levels. Following [1], the differences observed between the two series of stimuli in the 50% crossover points were calculated and compared statistically using ANOVA. Samples paired *t*-tests were also employed to test the level of significance of geminate responses between the two groups of stimuli at a specific step on a duration continuum.

## 3. RESULTS

### 3.1. Experiment 1

The perception results of the word-pair /pagɪ/-/ppagɪ/ in Experiment 1 are demonstrated in Figure 1, showing mean percentages of geminate responses to the stimuli made from the original /p/ (blue line) and the original /pp/ (red line). The horizontal line shows the crossover zones at 50%, while the vertical lines indicate the 50% crossover points between the two series of stimuli. Detailed measurements are provided in Table 2. It can be seen that increased amplitude following the original /p/ leads to more geminate responses, while decreased amplitude following the original /pp/ generates fewer geminate responses. Further, both response curves cross over the category boundaries with a particularly more rapid rise for the stimuli made from the original /p/. The crossovers, however, are incomplete, i.e. the mean percentages never reach 0% nor 100%.

ANOVA results reveal that the differences in geminate responses across the stimuli are statistically significant for the original /p/ ($F(5,220.5)=15.01$, $p<.001$) and also for the original /pp/ ($F(5,225.6)=9.618$, $p<.001$), suggesting that amplitude has a strong additional cue-value in geminate perception in KM. There are also ambiguous zones in the middle of the response curves. ANOVA results indicate that the difference between the two crossover points is significant ($F(1,536)=35.122$, $p<.001$), suggesting that, when amplitude is increased, listeners tend to perceive geminates much faster in the stimuli made from the

original /p/ (i.e. a 2-dB increase) than those made from the original /pp/ (i.e. a 6-dB increase).

**Figure 1**: Mean percentages of geminate responses to the voiceless stop stimuli in Experiment 1 (original /p/=blue line; original /pp/=red line).

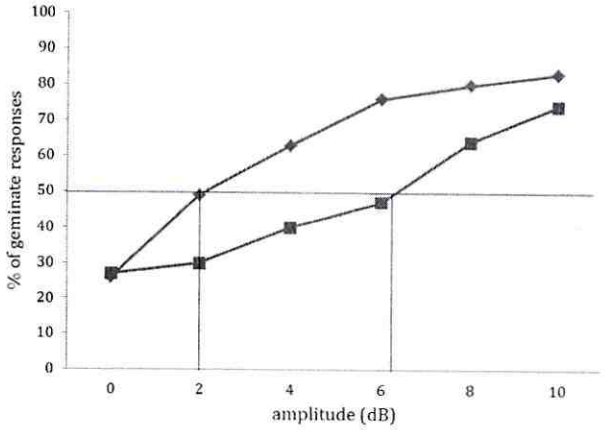



**Table 2**: Number of tokens and mean percentages of geminate responses to the voiceless stop stimuli in Experiment 1.

| Amplitude (dB) | n | Originally /p/ (%) | n | Originally /pp/ (%) | Sig. |
|---|---|---|---|---|---|
| 0 | 90 | 26 | 90 | 27 | 0.891 |
| 2 | 90 | 49 | 90 | 30 | <0.05 |
| 4 | 90 | 63 | 90 | 40 | <0.05 |
| 6 | 90 | 76 | 90 | 47 | <0.01 |
| 8 | 90 | 80 | 90 | 64 | 0.075 |
| 10 | 90 | 83 | 90 | 74 | 0.333 |

**Figure 2**: Mean percentages of geminate responses to the voiceless stop stimuli in Experiment 2 (original /p/=blue line; original /pp/=red line).

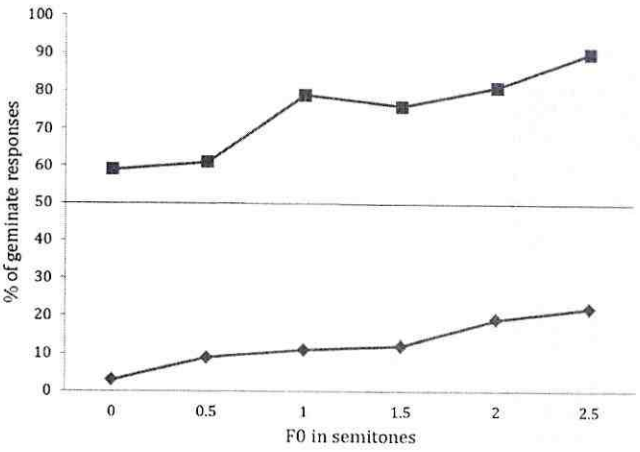



**Table 3**: Number of tokens and mean percentages of geminate responses to the voiceless stop stimuli in Experiment 2.

| F0 in semitones | n | Originally /p/ (%) | n | Originally /pp/ (%) |
|---|---|---|---|---|
| 0 | 90 | 3 | 90 | 59 |
| 0.5 | 90 | 9 | 90 | 61 |
| 1 | 90 | 11 | 90 | 79 |
| 1.5 | 90 | 12 | 90 | 76 |
| 2 | 90 | 19 | 90 | 81 |
| 2.5 | 90 | 22 | 90 | 90 |

### 3.2. Experiment 2

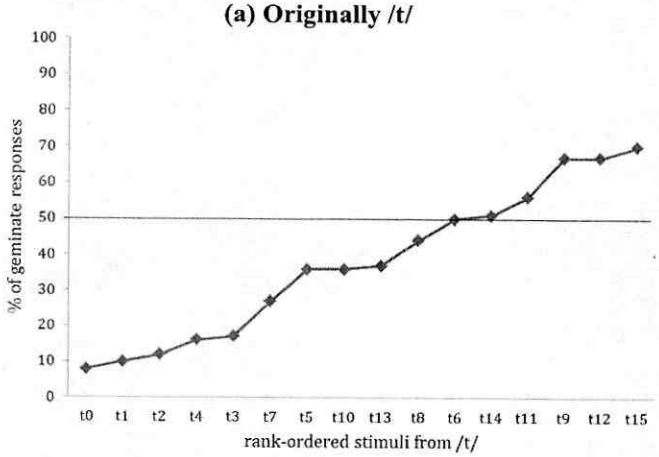
The perception results of the word-pair /pɪtʊ/-/ppɪtʊ/ in Experiment 2 are illustrated in Figure 2 and summarised in Table 3. It can be observed that increased F0 following the original /p/ causes more geminate responses, while lowered F0 following the original /pp/ results in fewer perceived geminates. Although there are no crossovers, both response curves converge gradually toward the perceptual boundary at 50%, especially in the case of the stimuli created from the original /pp/ in which the mean percentage of geminate responses is reduced from 90% to 59%. The results of one-way ANOVA reveal that the differences across the stimuli are just significant for the original /p/ ($F(5,82.55)=2.884$, $p<.05$) and highly significant for the original /pp/ ($F(5,157.7)=4.948$, $p<.001$), suggesting some perceptual cue-values of F0 on geminate perception in KM for both groups of stimuli.

### 3.3. Experiment 3

The perception results of the word-pair /tɪdo/-/ttɪdo/ in Experiment 3 are demonstrated in Figure 3 and summarised in Table 4.

**Figure 3**: Mean percentages of geminate responses to the voiceless stop stimuli in Experiment 3.

**(a) Originally /t/**




**(b) Originally /tt/**

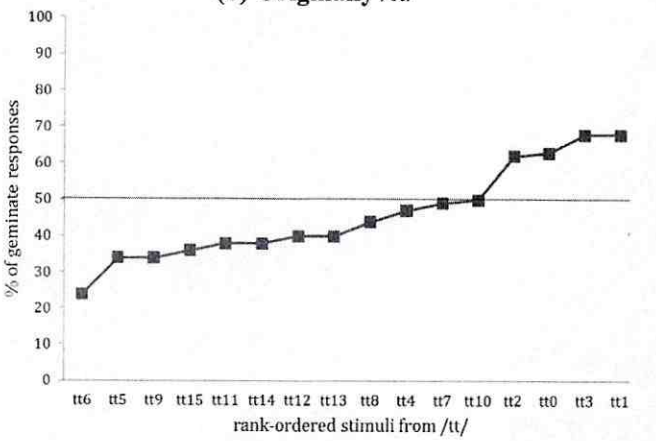


**Table 4**: Mean percentages of geminate responses to the voiceless stop stimuli in Experiment 3.

| (a) Originally /t/ | | (b) Originally /tt/ | |
|---|---|---|---|
| Stimuli (n=90) (amplitude/F0 variation) | % | Stimuli (n=90) (amplitude/F0 variation) | % |
| t0 (+0 dB, +0 ST) | 8 | tt6 (-6 dB, -0 ST) | 24 |
| t1 (+0 dB, +0.5 ST) | 10 | tt5 (-4 dB, -0 ST) | 34 |
| t2 (+0 dB, +1.0 ST) | 12 | tt9 (-6 dB, -0.5 ST) | 34 |
| t4 (+2 dB, +0 ST) | 16 | tt15 (-6 dB, -1.5 ST) | 36 |
| t3 (+0 dB, +1.5 ST) | 17 | tt11 (-4 dB, -1.0 ST) | 38 |
| t7 (+2 dB, +0.5 ST) | 27 | tt14 (-4 dB, -1.5 ST) | 38 |
| t5 (+4 dB, +0 ST) | 36 | tt12 (-6 dB, -1.0 ST) | 40 |
| t10 (+2 dB, +1.0 ST) | 36 | tt13 (-2 dB, -1.5 ST) | 40 |
| t13 (+2 dB, +1.5 ST) | 37 | tt8 (-4 dB, -0.5 ST) | 44 |
| t8 (+4 dB, +0.5 ST) | 44 | tt4 (-2 dB, -0 ST) | 47 |
| t6 (+6 dB, +0 ST) | 50 | tt7 (-2 dB, -0.5 ST) | 49 |
| t14 (+4 dB, +1.5 ST) | 51 | tt10 (-2 dB, -1.0 ST) | 50 |
| t11 (+4 dB, +1.0 ST) | 56 | tt2 (-0 dB, -1.0 ST) | 62 |
| t9 (+6 dB, +0.5 ST) | 67 | tt0 (-0 dB, -0 ST) | 63 |
| t12 (+6 dB, +1.0 ST) | 67 | tt3 (-0 dB, -1.5 ST) | 68 |
| t15 (+6 dB, +1.5 ST) | 70 | tt1 (-0 dB, -0.5 ST) | 68 |

Figure 3 shows mean percentages of geminate responses to fifteen stimuli made from the original /t/ (upper panel) and the original /tt/ (lower panel). In the response curves, following [4], the data are displayed as a rank-ordering of the perceptual effects, i.e. they are rank-ordered from the lowest (at the beginning of the continuum on the *x*-axes) to the highest mean percentage (at the right end of the continuum). Generally, it can be seen that there are more geminate responses when the amplitude and F0 values following the original /t/ are systematically increased (upper panel), while, by contrast, there are fewer geminate responses when the same values following the original /tt/ are carefully reduced (lower panel). Both response curves cross over the 50% category boundary, although the perceptual shift to the opposite category is incomplete. ANOVA results indicate that the differences in geminate responses across the stimuli are highly significant for the original /t/ ($F(15,585.2)=14.12$, $p<.001$) and also for the original /tt/ ($F(15,603.0)=4.053$, $p<.001$), indicating that the combined effects of amplitude and F0 can influence listeners' percepts of the consonant contrast in KM.

## 4. DISCUSSION AND CONCLUSIONS

This study has investigated the degree to which amplitude and F0 can influence the perception of the word-initial singleton/geminate contrast in KM, focusing on voiceless stops in which the primary acoustic cue of closure duration is unavailable. The results reported from Experiments 1 and 2 have shown that amplitude and F0, when modified on their own, manage to provide secondary cues to word-initial geminates in KM. However, the effect is relatively stronger in amplitude modification in which there are perceptual crossovers for both series of stimuli. In the final experiment, it was revealed that the combined effects of amplitude and F0 provide a better cue-value to the perceptual separation of the contrast in KM. The perceptual changes, nevertheless, are not necessarily brought about by systematic variation in both parameters. In some cases, amplitude variation alone is enough to cause significant geminate responses. That is, amplitude has a larger perceptual effect than F0.

The results in Experiment 1 require some comment; listeners respond differently to modified singletons and geminates, implying additional cues besides amplitude that may potentially influence listeners to perceive the stimuli created from the original /p/ as geminates. One of the most probable cues is the amplitude ratio across syllables. That is, when amplitude is gradually increased in the first syllable beginning with singletons, it may be potentially heard as similar to or louder than the second syllable, leading listeners to perceive manipulated singletons as geminates.

These perception results lend support to the KM production data on amplitude and F0, as reported in [8]. First, the results closely match the acoustic results found for the mean amplitude difference between KM voiceless stop singletons and geminates (5 dB). Second, as also reported in [8], the mean F0 differences between KM voiceless stop singletons and geminates (12 Hz for males and 13 Hz for females) are relatively small to have a large perceptual effect, which has already been proven in the current study. The KM perception results are partially in agreement with comparable experiments in PM; the individual effect of amplitude seems to be much stronger in KM than in PM [2], while F0 shows a similar weak effect in both Malay varieties [3]. With respect to the joint modification of amplitude and F0, like KM, the word-pairs in PM show perceptual crossovers in identification, which can be attributed to the manipulation of both syllables of disyllabic words in PM.

With regard to the wider implications of this study, the findings constitute important additions to the phonetic literature on consonant gemination. In particular, the perception results have shown that word-initial consonant gemination can be characterised by a complex interplay of secondary acoustic cues in addition to the primary cue, i.e., closure duration, particularly in the case of voiceless stops. Further examination is warranted to determine whether similar perceptual effects across syllables are also present in KM consonant gemination. Also, as to whether the effects of manipulation are present at other consonant types, this is subject to future experimental confirmation.

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